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COMPUTERIZED AIRCRAFT ATTRITION PROGRAM.(U)
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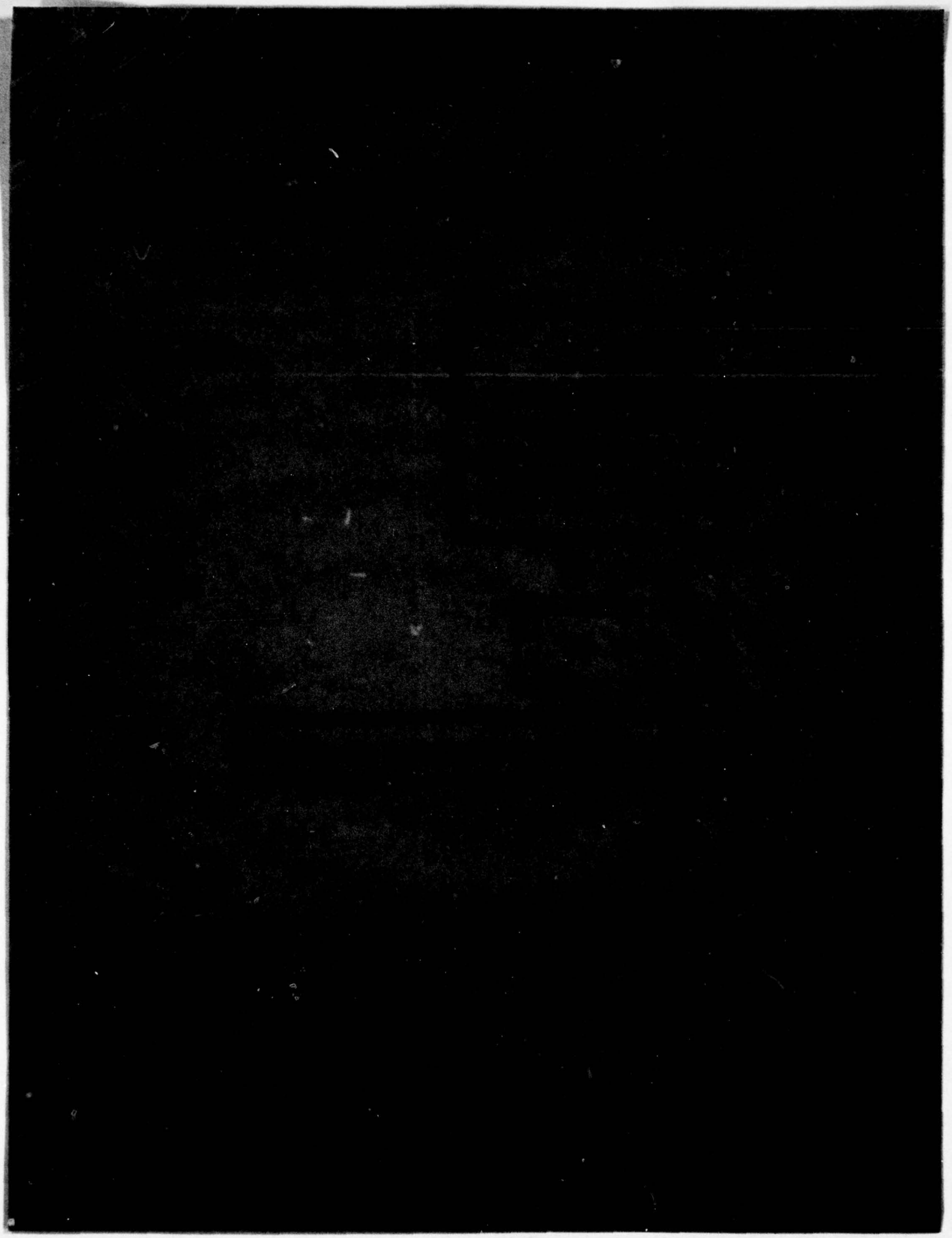

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The Computerized Aircraft Attrition Program (THAAP) presented in this report provides for a rapid method of calculating the forecasted attrition to be experienced by a given homogenous fleet of aircraft over a specified period of time. The THAAP program is designed to be a time-saving tool which will provide the quantity of aircraft attrited and resultant flying hour program for the adjusted operational fleet. The program will provide for the time-phased induction and withdrawal of aircraft from the fleet over the operational life of the system. The information or output from the program is intended to be used as input to time-phased cost estimates.

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20. ABSTRACT (continued). particularly operating and support cost estimates. The program's output is ideally suited for those studies which are performed manually or by computerized cost models which do not have a fleet attrition capability.

ACKNOWLEDGEMENTS

I wish to express my appreciation to Mr. Jim Boxx of this office who was responsible for creating The Computerized Aircraft Attrition Program (THAAP) I would also like to express my appreciation to the Branch secretary, Julia Oliver, for her excellent typing of this report.

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A. INTRODUCTION.

1. PURPOSE: This report provides documentation for The Computerized Aircraft Attrition Program (THAAP). It provides a general discussion of aircraft attrition and describes the program's methodology and operations. Included as appendices are Input/Output format requirements and a copy of the THAAP source listing.

2. BACKGROUND: Many historical cost estimates performed for aircraft systems are time-phased cost estimates. These estimates, particularly Operating and Support (O&S) cost estimates, have been greatly enhanced through consideration of time-phased aircraft induction/withdrawal and aircraft attrition. Incorporation of these factors into cost estimating has traditionally been a laborious and time consuming task for studies performed manually. Thus, a computerized program was needed to reduce tedium, response time, and establish standardized methods for dealing with aircraft attrition.

3. SCOPE: The THAAP program was created to support O&S cost studies. It provides for a rapid method of calculating aircraft attrition and allows for the time-phased induction and withdrawal of aircraft from an operational fleet.

4. OBJECTIVE: This report provides to the analyst all the information necessary to successfully exercise the THAAP program. It also discusses how the programs' output can be used as input to O&S cost studies.

B. GENERAL DISCUSSION OF ATTRITION.

1. It is appropriate to establish some basic definitions and ground-rules which will prevail throughout this report. In general, definitions will conform to established Army regulations. However, there are instances where alternative points of view will be presented.

a. PEACETIME REPLACEMENT FACTORS (PTRF): The Army Regulation governing the procedures for computing replacement factors is AR 710-60 (Reference 1). More specifically, the official computation formula is the following:

$$\text{Monthly Replacement Factor} = \frac{\dfrac{\text{Losses to Army inventory for period}}{\text{No. of quarters in period}} + \dfrac{\text{Sum of quarterly in-use densities}}{\text{No. of quarters in period}}}{3\ (\text{Months in quarter})}$$

This equation is simply the ratio of the average losses per month to the average density per month for a given time period. This equation represents the simplest and most straight-forward method for computing PTRF's. Because of its generic construction, it is applicable to virtually all primary items in the Army Inventory. There are, of course, many more elaborate methods for determining PTRF's. However, most of these are designed to determine PTRF's for specific primary items.

(1) One such specialized method for determining PTRF's for Army aircraft is presented in USAAVSCOM Technical Report 74-55 (Reference 2). This report utilizes regression analysis to develop predictive equations which relate aircraft losses to various characteristics of the Army aircraft systems. It is the USAAVSCOM methodology that presently provides the PTRF's for most Army aircraft systems. In fact, the USAAVSCOM methodology was used to determine

the PTRF's/attrition rates for publication in FM 101-20 (Reference 3).

(2) It should be noted that both methodologies described above are applicable to operational aircraft only. The AR 710-60 methodology requires that the in-use density be operational for at least 8 quarters. The USAAVSCOM methodology requires that the aircraft system be within the acceptable range of the data-base. Each aircraft system not specifically in the data base must be examined on a case by case basis before applicability can be ascertained. In general, the USAAVSCOM methodology is suitable for both rotary and fixed-wing aircraft. However, a specific exception is the BLACK HAWK. For developmental aircraft, such as the BLACK HAWK, factors must be derived from analogy and engineering estimates. These factors exist for most developmental aircraft and are available from their respective Project Management Offices (PMO).

b. ATTRITION RATES: In this report, attrition shall be defined as the (peace time) reduction of aircraft from the operational fleet through crash loss. The attrition rate is the rate in which aircraft are lost. More precisely, the attrition rate for an aircraft system is its PTRF. However, the attrition rate may be alternatively defined as the average number of aircraft lost per flight hour over a specified period of time. This rate may be mathematically defined by replacing the sum of quarterly in-use densities in the AR 710-60 definition with the sum of quarterly in-use flying hours for the same period. The attrition rate may be computed by dividing the PTRF by the average number of flying hours per aircraft per month. This form of the definition will be used for the remainder of this report. There are two other factors which significantly affect the operational fleet of a weapon system. These factors are an integral part of time-phased O&S cost studies.

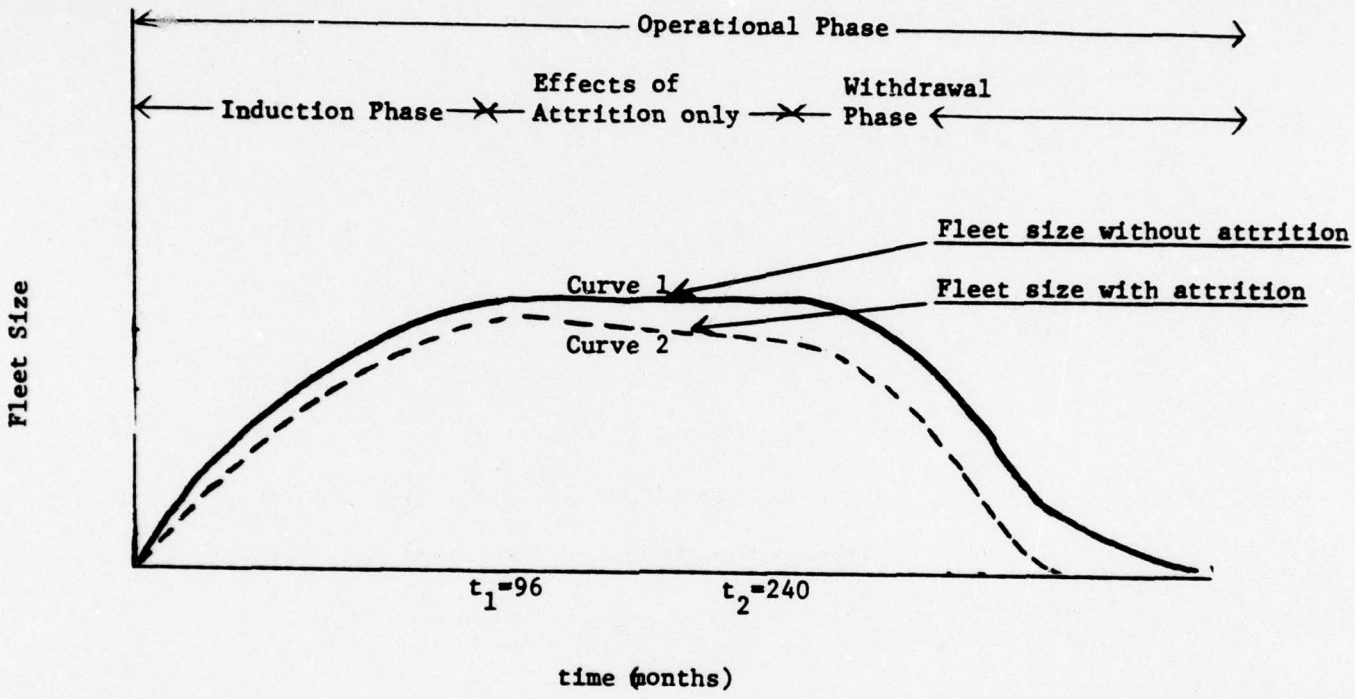
They are aircraft induction and withdrawal.

c. AIRCRAFT INDUCTION: The time-phased introduction of new production aircraft into the Army inventory; the phasing-in of new production aircraft into the operational fleet.

d. AIRCRAFT WITHDRAWAL: The reduction or phasing-out of aircraft from the operational fleet through management decision for either modernization or retirement.

2. The effects of attrition, induction and withdrawal on the operational fleet size of an aircraft system are illustrated in Figure 1. A graph is made by ploting the relative fleet size of a hypothetical aircraft system over the operational phase of the system's life. Curve-1 represents the fleet size overtime without the effects of attrition and Curve-2 represents the fleet size with attrition. During the induction phase of Curve-1, new production aircraft are introduced into the operational fleet at some predetermined rate until a maximum fleet size is obtained. Each aircraft is then maintained in the operational fleet for a given number of years. (For many aircraft systems, this period is 20 years). During the withdrawal phase, aircraft are phased-out at some predetermined rate until the fleet is depleted. In Curve-2, aircraft are inducted and phased-out in a similar fashion. However, in this case, the effect of aircraft attrition is present. The curve illustrates the impact of crash attrition without replacement. At each point in time, the numeric difference of the two curves, represents the cumulative number of attrited aircraft. For each time period the number of attrited aircraft is equal to the cumulative number at the end of the period less the cumulative number at the beginning of the period.

FIGURE 1. ATTRITION AND IN-USE DENSITIES



C. GENERAL DISCUSSION OF THE AIRCRAFT ATTRITION PROGRAM.

1. Methodology and Calculations.

The Computerized Aircraft Attrition Program (THAAP) is based on a cumulative theory of monthly fleet densities, flying hours and aircraft losses. This methodology was described graphically in Figure 1 of the preceding section. The THAAP Program receives, as input, time-phased information which is associated with Curve-1 (Figure 1), then through repetitive mathematical calculations applies a specified attrition rate and produces information associated with Curve 2 (Figure 1). This information consists of a monthly description of the cumulative number of aircraft lost due to attrition and the adjusted fleet flying hour program.

The procedure is initiated by reading, as input, the number of years of operations, aircraft attrition rate, report format, report title, average flying hours per aircraft per month, and induction and/or withdrawal schedules. The procedure itself consists of an attrition algorithm. The algorithm is performed once for each month of fleet operation. If N is the number of years of operation, then (N x 12) is the number of iterations performed by the algorithm. The algorithm consists of an ordered collection of mathematical equations which are defined as follows:

The in-use fleet density for the Jth month of the Ith year of operation is represented by the variable FLEET (I,J). For each iteration (i.e. month of operation), this variable is adjusted for aircraft attrition, induction and withdrawal. Mathematically, this relation is expressed as:

$$\text{FLEET}(I,J) = \text{FLEET} + \text{ADJUSTMENT}(I,J)$$

where,

$$\text{FLEET} = \begin{cases} 0 \text{ for I=1, J=1,} \\ \text{previous month fleet density for all other I,J;} \end{cases}$$

$$\text{ADJUSTMENT (I,J)} = \begin{cases} \text{Initial fleet size + Induction (I,J) - withdrawal (I,J)} \\ \text{for I=1, J=1} \\ \\ \text{Induction (I,J) - withdrawal (I,J) for all other I,J;} \end{cases}$$

where,

INDUCTION (I,J) = Quantity of aircraft inducted for the Jth month of the Ith year.

and

WITHDRAW (I,J) = Quantity of aircraft withdrawn for the Jth month of the Ith year.

Although the adjustment to the fleet is performed by the algorithm, the summation of its arguments (i.e. Initial fleet size, quantity inducted and quantity of withdrawal) are performed manually and supplied as a single input for each ADJUSTMENT (I,J).

The corresponding cumulative fleet flying hours associated with the FLEET (I,J) is FLYHRS (I,J). Mathematically, the expression is:

$$\text{FLYHRS (I,J)} = \text{CUMHOURS} + (\text{FLEET (I,J)} * \text{FLY}) \text{ for all I,J}$$

where,

CUMHOURS = cumulative fleet flying hours for the previous month

and

FLY = average monthly flying hours per aircraft per month.

The cumulative number of aircraft lost by attrition for the Jth month of the Ith year is determined by the equation:

$$\text{ATTRITION (I,J)} = \text{FLYHRS (I,J)} * \text{RATE for all I,J}$$

where,

RATE is the aircraft attrition rate (losses/flight-hr).

The end of month fleet density for the Jth month of the Ith year is equal to the fleet density at the beginning of Jth month less the integer number of aircraft lost during the month. Mathematically, the expression is:

FLEET = FLEET (I,J) - INTEGER (ATTRITION (,J) - LOSSES) for all I,J where,

INTEGER is a function which yields the greatest integer less than or equal to the value within the parenthesis and LOSSES are equal to INTEGER (ATTRITION (I,J)) from the preceding month.

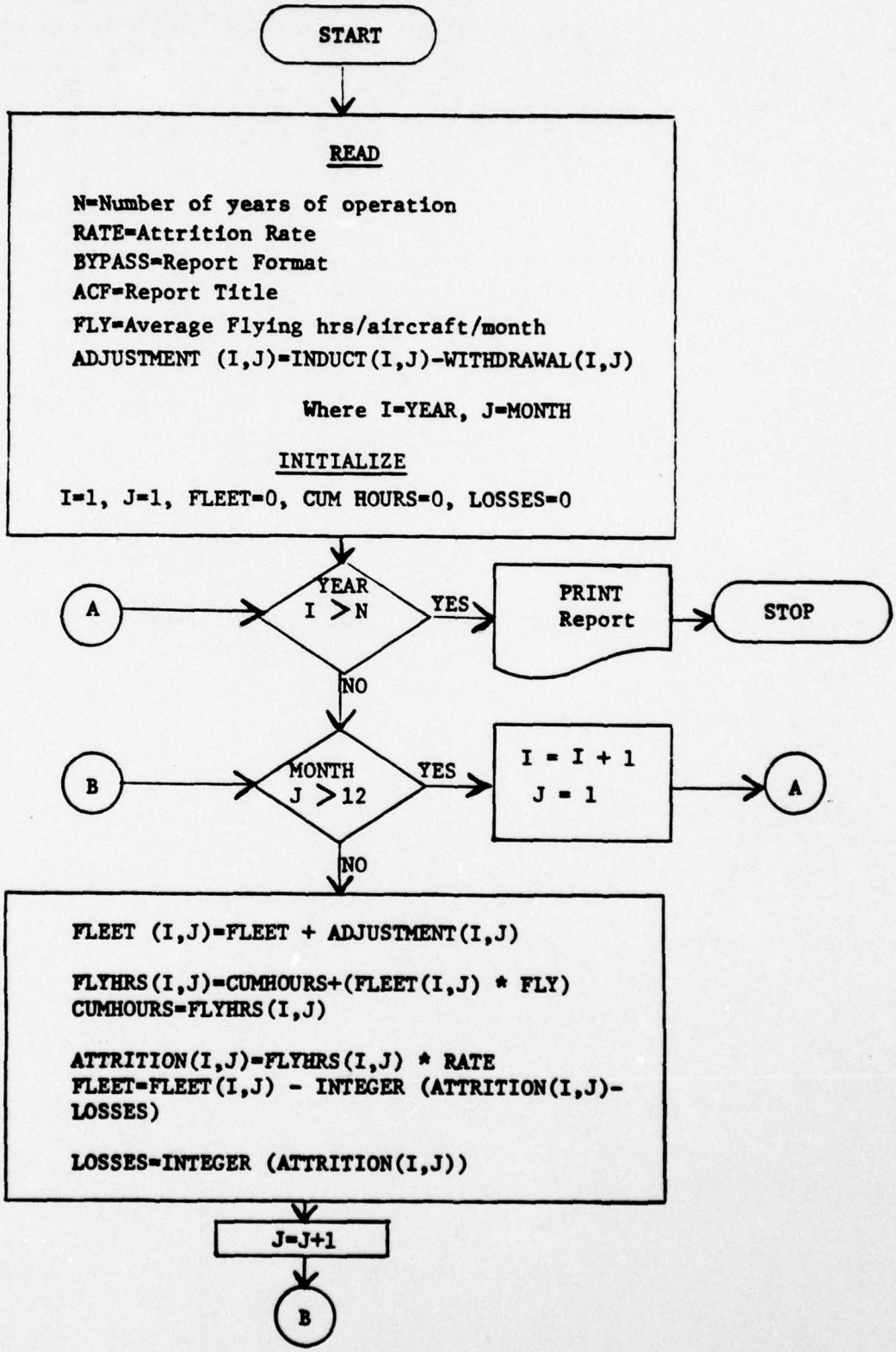
These equations provide the basis for the attrition algorithm. This algorithm provides a monthly record of the cumulative number of aircraft lost by attrition. It also provides a monthly flying hour program for those aircraft which are operational during each period. The fleet flying hours are aggregated by fiscal year and printed at the end of the program. An optional output display capability is incorporated into the program by use of the key-word, BYPASS. The selection capabilities of BYPASS are explained in detail in Appendix A. The THAAP attrition algorithm is illustrated in Figure 2.

2. Inputs to Cost Analysis.

The results of the THAAP Program can be used as input to Operating and Support (O&S) cost analysis. The procedure is simply to apply the THAAP's adjusted flying hour schedule to a pre-determined annual O&S cost per flight hour. The costs are first determined in constant dollars and then adjusted to current dollars. (For more details concerning cost estimating see AR 11-18, and DA PAM 11-4 (References 4 and 5 respectively)). The results of this procedure are the annual fleet operating costs which reflect aircraft induction, attrition and withdrawal. An example of such a cost estimate was the one performed for the CEFLY LANCER Task Force. In this case, a version of the THAAP Program was modified to accept the annual operating costs per flight hour. The O&S costs were then computed by the program based on the cost per flight hour and the adjusted flying hour program. The results, including the O&S cost were printed using a modified output procedure.

The THAAP Program may be applicable to certain computerized cost models which do not have an aircraft attrition capability. One such model is the Mixed Fleet

FIGURE 2. THAAP ATTRITION ALGORITHM



Operating and Support Cost Model, USAAVRADCOM Technical Report 77-3 (Reference 6). The application procedure for this cost model is somewhat different than the procedure described above. In this case, the quantities of aircraft lost through attrition are subtracted manually from the schedule of operational aircraft before they are input to the model. This procedure is somewhat tedious, but would be greatly enhanced by modifying the THAAP Program to supply directly the adjusted schedule.

3. Program Operations.

This program is written in PL-1 language and can be compiled using either PL-1F or PL-10 optimizing compliers. Presently these compliers are available on TSARCOM/AVRADCOM IBM 360-65 computer. The program requires approximately 100 K bytes of core storage to compile and 126K when executed from a load module.

The source program and load module have been placed on permanent storage in the Systems and Cost Analysis Division user library. The Job Control Language (JCL) required to access the load module and instructions for preparing input data are provided in Appendix A. The source listing of the computer program is provided in Appendix C, and a sample output is provided in Appendix B.

Contact point for assistance in running the program is the USAAVRADCOM Systems and Cost Analysis Division. No changes will be made to library source program without the approval of this office.

APPENDIX A

INPUT FORMAT

This appendix contains the instructions for preparing input data for the aircraft attrition program. It also contains a data sample and the Job Control Language (JCL) required to execute the program.

1. Instructions for preparing the Input Data.

When placing the input data on cards or creating an input data file on disc, the data must be separated by commas and placed in the following order:

Card 1:

Entry 1: Number of years of operation (maximum number is 26),

Entry 2: Aircraft attrition rate (losses/flight-hour),

Entry 3: Report format control (enter 0, 1, or 2),

Entry 4: Title of study,

Entry 5: Average number of flying hours per aircraft per month,

Entry 6: First fiscal years of operation.

Card 2 Thru N + 1: (N represents the number of years of operation)

Cards 2 thru N + 1 contain the aircraft density adjustment quantities (i.e. aircraft induction and withdrawal schedules). Each card represents one year of operation and contains twelve entries corresponding to the twelve months in a fiscal year (Oct, Nov,..., Sep). For each entry, supply the quantity of aircraft to be inducted or phased-out. If none, then enter zero. The quantity of Aircraft to be phased-out is entered as a negative number. If a number of aircraft are inducted and phased-out during the same month, then enter their algebraic sum. If the aircraft system under study is operational, then include the initial fleet size in the first entry of card 2. (i.e., the first month of operation).

An optional output display capability is incorporated in the program by use of the key-word, BYPASS. BYPASS is a variable which is assigned a value of either 0, 1 or 2. A value of zero will provide the complete output package. This consists of: (1) a monthly description of the cumulative number of aircraft lost by attrition; (2) a monthly description of the cumulative flying hour for the adjusted operational fleet; (3) a description of the cumulative flying hours program by fiscal year. A value of one will produce the reports labeled (2) and (3) above; a value of two will yield only the cumulative flying hour program by fiscal year. The BYPASS feature is useful in the case where only partial output is desired and the output is to be printed on a low-speed printer (e.g. interactive processing on the IBM-2741 TSO terminal).

FIGURE A-1. SAMPLE DATA FOR THE THAAP PROGRAM.

Figure A-1 is an illustration of a THAAP data set created on disc. The input format is the same, whether the data is on disc or on computer cards.

```
24,.00004,0,'C-12A',50,74
0,1,1,3,2,2,2,2,3,2,2,0
0,0,0,0,0,1,1,1,2,2,2,2
2,1,2,2,2,1,1,1,2,2,2,2
2,1,2,2,2,1,1,1,2,2,2,2
2,1,2,2,2,1,1,1,2,2,2,2
2,1,2,2,2,1,1,1,2,2,2,2
2,1,2,2,2,0,0,0,0,0,0,0
0,0,0,0,0,0,0,0,0,0,0,0
0,0,0,0,0,0,0,0,0,0,0,0
0,0,0,0,0,0,0,0,0,0,0,0
0,0,0,0,0,0,0,0,0,0,0,0
0,0,0,0,0,0,0,0,0,0,0,0
0,0,0,0,0,0,0,0,0,0,0,0
0,0,0,0,0,0,0,0,0,0,0,0
0,0,0,0,0,0,0,0,0,0,0,0
0,0,0,0,0,0,0,0,0,0,0,0
0,0,0,0,0,0,0,0,0,0,0,0
0,0,0,0,0,0,0,0,0,0,0,0
0,0,0,0,0,0,0,0,0,0,0,0
0,0,0,0,0,0,0,0,0,0,0,0
0,0,0,0,0,0,0,0,0,0,0,0
0,0,0,0,0,0,0,0,0,0,0,0
0,0,0,0,0,0,0,0,0,0,0,0
0,0,0,0,0,0,0,0,0,0,0,0
0,0,0,0,0,0,0,0,0,0,0,0
0,0,0,0,0,0,0,0,0,0,0,0.
```

FIGURE A-2. SAMPLE JCL FOR THE THAAP PROGRAM.

The following examples of JCL are given for illustrative purposes only. The user should prepare the appropriate Job Control Language for hardware peculiar to their organization. TSARCOM/AVRADCOM users of the IBM 360-65 S&E Computer, must use the correct job card for their Directorate and office. Figure A-2 is appropriate for batch processing with a predefined data set. In this example, the data set name is "USERID·THAAP·DATA". Figure A-3 is appropriate for batch processing with the data created on computer cards and inserted within the JCL.

```
//LAVBCQR3  JOB  (2T04,L060),'TATE',CLASS=K
//STEP1 EXEC  PGM=AAP,REGION=126K
//STEP1.IR  DD DSN=LAVRCCA.THAAP.LOAD,DISP=SHR
//INN       DD DDNAME=SYSIN
//SYSPRINT  DD SYSOUT=A
//SYSIN     DD DSN=USERID.THAAP.DATA,DISP=SHR
/*
```

FIGURE A-3. SAMPLE JOB CONTROL LANGUAGE AND INPUT DATA.

```
//LAVRCOR3  JOB  (2T04,L060),'TAIT',CLASS=K
//STEP1 EXEC PGM=BAAP,REGION=126K
//STEPLIB  DD DSN=LAVRCCA.THAAP.LOAD,DISP=SHR
//INN      DD DDNAME=SYSIN
//SYSPRINT    DD SYSOUT=A
//SYSIN    DD *
2A,,00004,0,'C-12A',50,74
0,1,1,3,2,2,2,2,3,2,2,0
0,0,0,0,0,1,1,1,2,2,2,2
2,1,2,2,2,1,1,1,2,2,2,2
2,1,2,2,2,1,1,1,2,2,2,2
2,1,2,2,2,1,1,1,2,2,2,2
2,1,2,2,2,1,1,1,2,2,2,2
2,1,2,2,2,0,0,0,0,0,0,0
0,0,0,0,0,0,0,0,0,0,0,0
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0,0,0,0,0,0,0,0,0,0,0,0
0,0,0,0,0,0,0,0,0,0,0,0
0,0,0,0,0,0,0,0,0,0,0,0
0,0,0,0,0,0,0,0,0,0,0,0
0,0,0,0,0,0,0,0,0,0,0,0
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0,0,0,0,0,0,0,0,0,0,0,0
0,0,0,0,0,0,0,0,0,0,0,0
0,0,0,0,0,0,0,0,0,0,0,0
0,0,0,0,0,0,0,0,0,0,0,0
0,0,0,0,0,0,0,0,0,0,0,0
0,0,0,0,0,0,0,0,0,0,0,0
0,0,0,0,0,0,0,0,0,0,0,0
0,0,0,0,0,0,0,0,0,0,0,0
/*
```

APPENDIX B

OUTPUT FORMAT

C-12A

NO OF AIRCRAFT LOST BY ATTRITION

FY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
78	0.00	0.00	0.01	0.02	0.03	0.05	0.07	0.10	0.13	0.16	0.20	0.24
79	0.28	0.32	0.36	0.40	0.44	0.49	0.53	0.58	0.63	0.68	0.74	0.80
80	0.87	0.93	1.01	1.08	1.16	1.24	1.32	1.40	1.49	1.58	1.68	1.78
81	1.88	1.99	2.10	2.21	2.33	2.45	2.57	2.69	2.81	2.94	3.08	3.21
82	3.35	3.50	3.64	3.79	3.95	4.10	4.26	4.42	4.58	4.74	4.91	5.09
83	5.26	5.44	5.62	5.81	6.00	6.19	6.38	6.58	6.78	6.98	7.18	7.39
84	7.60	7.82	8.04	8.26	8.48	8.70	8.93	9.15	9.37	9.60	9.82	10.04
85	10.26	10.48	10.70	10.92	11.14	11.36	11.58	11.79	12.01	12.23	12.44	12.66
86	12.88	13.09	13.31	13.52	13.73	13.95	14.16	14.37	14.59	14.80	15.01	15.22
87	15.43	15.64	15.85	16.06	16.27	16.48	16.68	16.89	17.10	17.31	17.51	17.72
88	17.92	18.13	18.33	18.54	18.74	18.95	19.15	19.35	19.55	19.76	19.96	20.16
89	20.36	20.56	20.76	20.96	21.16	21.36	21.56	21.75	21.95	22.15	22.35	22.54
90	22.74	22.93	23.13	23.32	23.52	23.71	23.91	24.10	24.29	24.48	24.68	24.87
91	25.06	25.25	25.44	25.63	25.82	26.01	26.20	26.39	26.57	26.76	26.95	27.14
92	27.32	27.51	27.70	27.88	28.07	28.25	28.44	28.62	28.80	28.99	29.17	29.35
93	29.54	29.72	29.90	30.08	30.26	30.44	30.62	30.80	30.98	31.16	31.34	31.52
94	31.70	31.87	32.05	32.23	32.40	32.58	32.76	32.93	33.11	33.28	33.46	33.63
95	33.80	33.98	34.15	34.32	34.50	34.67	34.84	35.01	35.18	35.35	35.52	35.69
96	35.86	36.03	36.20	36.37	36.54	36.70	36.87	37.04	37.21	37.37	37.54	37.70
97	37.87	38.04	38.20	38.36	38.53	38.69	38.86	39.02	39.18	39.34	39.51	39.67

C-12A

FLEET FLYING HOURS WITH ATTRITION

FY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
78	0	50	150	400	750	1200	1750	2400	3200	4100	5100	6100
79	7100	8100	9100	10100	11100	12150	13250	14400	15650	17000	18450	20000
80	21450	23150	25150	27000	29050	30050	33000	35100	37300	39600	42000	44500
81	47100	49750	52600	55300	58200	61150	64150	67200	70350	73600	76950	80350
82	83850	87400	91050	94800	98650	102550	106450	110400	114450	118600	122850	127200
83	131400	136050	140800	145750	150900	156200	161650	167250	169400	174450	179600	184800
84	190100	195450	200900	206400	212000	217600	223200	228800	234350	239900	245450	251000
85	256500	262000	267500	273000	278500	283950	289400	294850	300300	305700	311100	316500
86	321900	327300	332650	338000	343350	348700	354050	359350	364650	369950	375250	380500
87	385750	391000	396250	401500	406700	411900	417100	422300	427500	432650	437800	442950
88	448100	453250	458350	463450	468550	473650	478750	483800	488850	493900	498950	504000
89	509000	514000	519000	524000	529000	533950	538900	543850	548800	553750	558650	563550
90	568450	573350	578250	583100	587950	592800	597650	602500	607300	612100	616900	621700
91	626500	631250	636000	640750	645500	650250	654950	659650	664350	669050	673750	678450
92	683100	687750	692400	697050	701700	706300	710900	715500	720100	724700	729300	733850
93	738400	742950	747500	752050	756550	761050	765550	770050	774550	779050	783500	787950
94	792400	796850	801300	805700	810100	814500	818900	823300	827700	832050	836400	840750
95	845100	849450	853800	858100	862400	866700	871000	875300	879550	883800	888050	892300
96	896550	900800	905050	909200	913400	917600	921800	926000	930150	934300	938450	942600
97	946750	950900	955050	959100	963200	967300	971400	975500	979550	983600	987650	991700

C-12A

FLEET FLYING HOURS WITH ATTRITION

FY	YR TOTAL	CUM TOTAL
78	6100	6100
79	13900	20000
80	24500	44500
81	35850	80350
82	46850	127200
83	57600	184800
84	66200	251000
85	65500	316500
86	64000	380500
87	62450	442950
88	61050	504000
89	59550	563550
90	58150	621700
91	56750	678450
92	55400	733850
93	54100	787950
94	52800	840750
95	51550	892300
96	50300	942600
97	49100	991700

APPENDIX C

SOURCE LISTING

```
MEMBER NAME  AAP
00000010 (NOUEL):PROCEDURE OPTIONS(MAIN);
00000020 DCL FY(26);
00000030 DCL FLY;
00000040 DCL FLS(26,12)FLOAT;
00000050 DCL ATH FLOAT;
00000060 DCL FTA(26,12)FLOAT;
00000070 DCL ST1 FLOAT;
00000080 DCL ST2 FLOAT;
00000090 DCL NAA(26,12)FLOAT(8);
00000100 DCL CT(26)FLOAT;
00000110 DCL YT(26)FLOAT;
00000120 DCL ST3 FLOAT;
00000130 DCL ACF CHAR(5);
00000140 DCL YR FLOAT;
00000150 DCL FYR;
00000160 OPEN FILE(SYSPRINT) LINESIZE(132);
00000160 K=0;
00000170 /*INPUT FLEET SIZE,FLYING HOURS PER MTH,AND ATTRITION RATE PER FH*/
00000180 ST1:GET FILE(INN) LIST(YR,ATH,BYPASS,ACF,FLY,FYR);
00000190 IF YR > 26 THEN YR = 26;
00000200 FY(1) = FYR;
00000210 DO J=2 TO YR;
00000230 FY(J) = FY(J-1) + 1;
00000240 IF FY(J) >= 100 THEN FY(J) = FY(J) - 100;
00000250 END;
00000260 DO I=1 TO YR;
00000270 DO J=1 TO 12;
00000280 GET FILE(INN) LIST(FLS(I,J));
00000290 END;
00000300 END;
00000310 /*CALCULATE TOTAL FLEET FLYING HOURS INCL ATTRITION*/
00000320 ST1=0;
00000330 ST2=0;
00000340 NAA=0;
00000350 ST3=0;
00000360 N=1;
00000370 DO I=1 TO YR;
00000380 DO J=1 TO 12;
00000390 FLS(I,J)=ST1*FLS(I,J);
00000400 ST1=FLS(I,J);
00000410 FTA(I,J)=(FLY*FLS(I,J))*ST2;
00000420 ST2=FTA(I,J);
00000430 NAA(I,J)=ST2*ATR;
00000440 ADJ:IF NAA(I,J) >= N THEN DO;
00000450 ST1=ST1-1;
00000460 N=N+1;
00000470 GO TO ADJ;
00000480 END;
00000490 END;
00000500 CT(I)=ST2;
00000510 YT(I)=CT(I)-ST3;
00000520 ST3=CT(I);
00000530 END;
00000540 IF BYPASS>=1 THEN GO TO LOOP;
00000550 PUT EDIT(ACF)(SKIP,A(5));
00000560 PUT EDIT('NO OF AIRCRAFT LOST BY ATTRITION','FY','OCT','NOV','DEC',
00000570 'JAN','FEB','MAR','APR','MAY','JUN','JUL','AUG','SEP')
00000580 (SKIP(2),A(43),A(32),SKIP(3),A(11),A(2),X(7),A(3),11 (X(5),A(3)));
```

```
MEMBER NAME  AAP
00000590 DO I=1 TO YRS;
00000600 PUT EDIT(FY(I),(NAA(I,J) DO J=1 TO 12))(SKIP(2),X(11),F(2),X(3),
00000610 12 (F(8,2)));
00000620 END;
00000630 LOOP1:IF BYPASS>=2 THEN GO TO LOOP2;
00000640 PUT PAGE;
00000650 PUT EDIT(ACF)(SKIP,X(57),A(5));
00000660 PUT EDIT('FLEET FLYING HOURS WITH ATTRITION')(SKIP(2),A(44),A(33));
00000670 PUT EDIT(' FY','OCT','NOV','DEC','JAN','FEB','MAR','APR','MAY','JUN','J
00000680 'AUG','SEP')(SKIP(2),A(3),12 (X(7),A(3)));
00000690 DO I=1 TO YRS;
00000700 PUT EDIT(FY(I),(FTA(I,J) DO J=1 TO 12))(SKIP(2),F(3),12 F(10));
00000710 END;
00000720 LOOP2:IF BYPASS>=3 THEN GO TO LOOP3;
00000730 PUT PAGE;
00000740 PUT EDIT(ACF)(SKIP,X(57),A(5));
00000750 PUT EDIT('FLEET FLYING HOURS WITH ATTRITION:')(SKIP(2),A(47),A(33));
00000760 PUT EDIT('FY','YR TOTAL','CUM TOTAL')(SKIP(3),X(45),A(2),X(8),A(8),X(10
00000770 DO I=1 TO YRS;
00000780 PUT EDIT(FY(I),YT(I),CT(I))(SKIP(2),X(64),F(3),X(4),F(12),X(7),F(12));
00000790 END;
00000800 K=K+1;
00000810 IF K<1 THEN GO TO STT;
00000820 LOOP3:END CST;
```

APPENDIX D

GLOSSARY OF TERMS AND ACRONYMS

ACRONYMS

1. AR - Army Regulation
2. AVRADCOM - See USAAVRADCOM
3. FM - Field Manual
4. JCL - Job Control Language
5. K - Thousands
6. O&S - Operating and Support
7. PMO - Project/Program Management Office
8. PTRF - Peacetime Replacement Factors
9. S&E - Scientists and Engineers
10. THAAP - The Computerized Aircraft Attrition Program
11. TSARCOM - Troop Support and Aviation Materiel Readiness Command
12. TSO - Time Sharing Operations
13. USAAVRADCOM - United States Army Aviation Research and Development Command
14. USAAVSCOM - United States Army Aviation Systems Command

GLOSSARY OF TERMS

Algorithm - A rule or procedure for solving a mathematical problem that frequently involves repetition of an operation.

Attrition (Aircraft Attrition)- The (peacetime) reduction of aircraft from the operation fleet through crash loss.

Attrition Rate - The rate in which aircraft are lost through crashes. The number of losses per month; the number of losses per flight-hour, etc. (See attrition)

Constant Year Dollars - An estimate is said to be in constant dollars if costs for all work are adjusted so that they reflect the level of prices of the base year.

Current Year or "Then Year" Dollars - are current to the year the work is performed. When prior costs are stated in current year dollars, the figures given are the actual amounts paid out. When future costs are stated in current year dollars, the figures given are the actual amounts which will be paid including any amounts due to future price changes.

Data-base - In this text, the term data-base refers to the collection of historical information of Army aircraft systems which are used to develop a mathematical equation, cost estimating relationships, etc, by means of regression analysis. The collection consists of the set of (N + 1)-tuples $(Y_m, X_{(1,m)}, X_{(2,m)}, \ldots, X_{(n,m)})$ where M is the sample size, Y_m is the dependent variable; $X_{(1,m)}, X_{(2,m)}, \ldots, X_{(n,m)}$ are a collection of N independent variables which are characteristics of the aircraft system and are logically related to the dependent variable Y_m.

Induction (Aircraft Induction) - A time-phased introduction of new production aircraft into the Army inventory; Also, the phasing-in of new production aircraft into the operational fleet.

Operating and Support Cost Estimate - An estimate of the sum of all costs resulting from the operation, maintenance and support (including personnel support) of the weapon system after it is accepted into the Army inventory.

Peacetime Replacement Factor (PTRF) - The PTRF is the average monthly replacement factor for losses to the Army inventory. The PTRF is generally based on the most recent 8 quarters of current experience. Mathematically, it is the ratio of the losses to Army inventory for the period to the sum of the quarterly in-use densities for the period all divided by the number of months in a quarter, (3).

Primary item - An item of materiel which normally appears in requirements and authorization documents. The primary item (P) can be identified as an end item, component, set, assemblage, or system.

Time-phased - The identification or aggregation of activities, events, and/or associated costs by month, quarter or fiscal year.

Withdrawal (Aircraft withdrawal) - The reduction or phasing-out of aircraft from the operational fleet through management decision for either modernization or retirement.

D. REFERENCES.

1. AR 710-60, Inventory Management Standard Study Number System and Replacement Factors, Wash., D.C., Department of the Army, 9 January 1973.

2. USAAVSCOM Technical Report 74-55, U.S. Army Aircraft Peacetime Replacement Factors, St. Louis, MO: U.S. Army Aviation Systems Command, Systems Analysis Office, June 1975.

3. FM 101-20, U.S. Army Aviation Planning Manual. Washington, D.C.: Department of the Army, February 1976.

4. AR 11-18, The Cost Analysis Program, Washington, D.C.: Department of the Army, 10 October 1975.

5. DA PAM 11-4, Operating and Support Cost Guide for Army Materiel Systems, Washington, D.C.: Department of the Army, April 1976.

6. USAAVRADCOM Technical Report 77-3, Mixed Fleet Operating and Support Cost Model, St. Louis, MO: U.S. Army Aviation Research and Development Command, Directorate for Plans and Analysis, Systems and Cost Analysis Division, Estimates and Studies Branch, August 1977.

E. BIBLIOGRAPHY.

1. AR 11-18, The Cost Analysis Program, Washington, D.C.: Department of the Army, 10 October 1975.

2. AR 710-60, Inventory Management Standard Study Number System and Replacement Factors, Washington, D.C., Department of the Army, 9 January 1973.

3. DA PAM 11-4, Operating and Support Cost Guide for Army Materiel Systems, Washington, D.C.: Department of the Army, April 1976.

4. FM 101-20, U.S. Army Aviation Planning Manual, Washington, D.C.: Department of the Army, February 1976.

5. USAAVRADCOM Technical Report 77-3, Mixed Fleet Operating and Support Cost Model, St. Louis, MO: U.S. Army Aviation Research and Development Command, Directorate for Plans and Analysis, Systems and Cost Analysis Division, Estimates and Studies Branch, August 1977.

6. USAAVSCOM Technical Report 74-55, U.S. Army Aircraft Peacetime Replacement Factors, St. Louis, MO: U.S. Army Aviation Systems Command, Systems Analysis Office, June 1975.

7. USAAVSCOM Technical Report 75-30, A Computer Model for Aircraft PIP and ECP Economic Analysis, St. Louis, MO: U.S. Army Aviation Systems Command, Office of the Comptroller, Cost Analysis Division, August 1975.

8. USAAVSCOM Technical Report 75-54, A Time Phased Parametric Life Cycle Cost Model for Army Helicopters, St. Louis, MO: U.S. Army Aviation Systems Command, Office of the Comptroller, Cost Analysis Division, Estimates and Studies Branch, January 1976.

9. USAAVSCOM Technical Report 77-5, AVSCOM Maintenance Operating and Support Cost Model, St. Louis, MO: U.S. Army Aviation Systems Command, Office of the Comptroller, Cost Analysis Division, Estimates and Studies Branch, February, 1977.